REMARKS

This Preliminary Amendment cancels, without prejudice, claims 1 to 7 in the underlying PCT Application No. PCT/EP2005/051997 and adds new claims 8 to 15. The new claims, inter alia, conform the claims to United States Patent and Trademark Office rules and does not add any new matter to the application.

In accordance with 37 C.F.R. § 1.125(b), the Substitute Specification (including the Abstract) contains no new matter. The amendments reflected in the Substitute Specification (including Abstract) are to conform the Specification and Abstract to United States Patent and Trademark Office rules or to correct informalities. As required by 37 C.F.R. §§ 1.121(b)(3)(ii) and 1.125(c), a Marked-Up Version of the Substitute Specification comparing the Specification of record and the Substitute Specification also accompanies this Preliminary Amendment. Approval and entry of the Substitute Specification (including Abstract) are respectfully requested.

The underlying PCT Application No. PCT/EP2005/051997 includes an International Search Report, dated June 16, 2005, a copy of which is included. The Search Report includes a list of documents that were considered by the Examiner in the underlying PCT application.

It is respectfully submitted that the subject matter of the present application is new, non-obvious and useful. Prompt consideration and allowance of the application are respectfully requested.

Respectfully submitted,

Dated: January 6, 2006

By: _____
Gerard A. Messina
Reg. No. 35,952

R.N. 42,194

KENYON & KENYON LLP
One Broadway
New York, New York 10004
(212) 425-7200
CUSTOMER NO. 26646

FUEL INJECTOR

~~Background Information~~

FIELD OF THE INVENTION

The present invention ~~is based on~~ **relates to** a fuel injector ~~of the type set forth in the main claim~~.

BACKGROUND INFORMATION

~~Known from DE~~ **Described in German Published Patent Application No.** 101 52 415 [[A1]], for ~~instance~~ **example**, is an outwardly opening fuel injector having a conical sealing seat. The fuel injector includes a valve needle, which is guided in a nozzle body, is actuable by an actuator and acted upon by a restoring spring [[in]] such ~~a manner~~ that a valve-closure member, which is in operative connection with the valve needle, is retained in sealing contact on a valve-seat surface. Formed on a downstream end of the fuel injector is a projection, which juts out beyond the valve-closure body of the fuel injector.

A particular disadvantage of the fuel injector ~~known from DE~~ **described in German Published Patent Application No.** 101 52 415 [[A1]] is that the manufacture of the raised area of the nozzle body compared to the valve-closure body, while protecting the conical sealing seat from damage, is labor-intensive in the production and itself is susceptible to damage because of its exposed position, such damage having an adverse effect on the jet pattern of the fuel injector and also on the desired protective function of the raised region.

~~Summary of the Invention~~

SUMMARY

In contrast, ~~the~~ **a** fuel injector according to **an example embodiment of** the present invention~~, having the characterizing features of the main claim, has the advantage~~ **may provide** that

EV322952562

simple measures with respect to the contour of the nozzle body and the valve-closure body **may** provide reliable protection of the sealing seat against mechanical damage during transportation and installation of the fuel injector in that a transition region between the nozzle body and the valve-closure body has a concave design.

~~Advantageous further developments of the fuel injector specified in the main claim are rendered possible by the measures elucidated in the dependent claims.~~

~~In an advantageous manner an~~ **An** angle between the mutually abutting surfaces of the nozzle body and the valve-closure body ~~amounts~~ **may amount** to less than 180°, so that the sum of the two edge angles of the edges on the nozzle body and the valve-closure body is greater than 180°, i.e., the two edges are obtuse-angled.

Moreover, it ~~is advantageous~~ **may be provided** that the transition region with the edges is positioned in a recessed manner compared to a surface plane of the fuel injector.

~~Brief Description of the Drawing~~

~~An exemplary embodiment~~ **Example embodiments** of the present invention ~~is represented in simplified form in the drawing and elucidated~~ **are described below** in greater detail in the following description **with reference to the appended Figures**.

~~The figures show:~~

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 **is** a schematic ~~section~~ **cross-sectional view** through **a fuel injector according to** an exemplary embodiment of ~~a fuel injector configured according to~~ the present invention[[;]].

Fig. 2 **is** a schematic comparative ~~sectional~~ **cross-sectional** view of the ~~exemplary embodiment of the~~ fuel injector ~~configured according to the present invention, shown~~ **illustrated** in Figure 1, in region II in Figure 1, and a **conventional** fuel injector ~~according to the related art; and~~.

Fig. 3 **is** a schematic comparative illustration of a sealing seat of a **conventional** fuel injector ~~according to the related art~~ and a fuel injector according to **an example embodiment of** the present invention in ~~the~~ **an** open state of the fuel injector.

~~Detailed Description of the Exemplary Embodiment~~

DETAILED DESCRIPTION

An exemplary embodiment of a fuel injector 1 ~~according to the present invention~~, ~~shown~~ **illustrated** in Figure 1, is ~~designed~~ **arranged** in the form of a fuel injector 1 for fuel-injection systems of mixture-compressing internal combustion engines having externally supplied ignition. Fuel injector 1 [[is]] **may be** particularly suited for the direct injection of fuel into a combustion chamber ~~(not shown)~~ of an internal combustion engine.

Fuel injector 1 includes a housing body 2 and a nozzle body 3, in which a valve needle 4 is positioned. Valve needle 4 is in operative connection to a valve closure member 5, which cooperates with a valve seat surface 6 to form a sealing seat. The fuel injector ~~in the exemplary embodiment~~ is an outwardly opening fuel injector 1. It includes an actuator 7, which is ~~embodied~~ **arranged** as a piezoelectric actuator 7 ~~in the exemplary embodiment~~. On one side, the actuator is braced on housing body 2, and on the other side it is braced on a shoulder 8, which is in operative connection to valve needle 4. Downstream from shoulder 8 is a restoring spring 9, which in turn is braced on nozzle body 3.

Valve needle 4 has a fuel channel 10 through which the fuel, conveyed through an inflow-side central fuel feed 11, is guided to the sealing seat. On the inflow side of the sealing seat, a swirl chamber 12 is formed into which fuel channel 10 discharges.

In the neutral state of fuel injector 1, the force of restoring spring 9 acts upon shoulder 8 counter to the lift direction, [[in]] such ~~a way~~ that valve closure member 5 is held in sealing contact on valve seat surface 6. When piezoelectric actuator 7 is energized, it expands in the axial direction, counter to the spring force of restoring spring 9, so that shoulder 8 with valve needle 4, which is joined to shoulder 8 by force-locking, is moved in the lift direction. Valve-closure member 5 lifts off from valve-seat surface 6, and the fuel supplied via fuel channel 10 is spray-discharged.

When the energizing current is switched off, the axial expansion of piezoelectric actuator 7 is reduced, so that the pressure of restoring spring 9 moves valve needle 4 counter to the lift direction. Valve closure member 5 sets down on valve seat surface 6, and fuel injector 1 is closed.

Conventional fuel injectors ~~1 usually~~ **may** have a convex transition region 13 in the area of the sealing seat, as schematically ~~shown~~ **illustrated** on the right side in Figure 1. This surface shape, which is made up of a surface 14 of nozzle body 3 and a surface 15, abutting thereon on the downstream side, of valve-closure member 5, in most cases is chosen to ensure easy manufacturability and a smooth surface~~; however~~. **However**, it ~~has the decisive disadvantage~~ **may be disadvantageous** that edges 16, 17 of nozzle body 3 and valve closure body 5, respectively, are ~~lying~~ exposed due to the convex shape of transition region 13, and may be damaged as a

result, for ~~instance~~ **example,** during transportation or installation of fuel injector 1. Since the shape of edges 16, 17 is responsible for the form of the mixture cloud and the jet pattern, damage in this region ~~has~~ **may have** an adverse effect on the cylinder charge, on the combustion and on the emission values of the internal combustion engine.

In contrast thereto, according to **an example embodiment of** the present invention, transition region 13 in the area of the region of the sealing seat does not have a convex, but a concave shape, as ~~shown~~ **illustrated** in Figure 1 on the left. The measures ~~according to the present invention~~ **hereof** are illustrated in Figures 2 and 3 in enlarged form and explained in greater detail in the following description.

Figures 2 and 3 ~~show~~ **illustrate**, in ~~a part-sectional view~~ **partial cross-sectional views**, the cut-away portion -- denoted by II in Fig. 1 -- from fuel injector 1 configured according to **an example embodiment of** the present invention as ~~shown~~ **illustrated** in Figure 1 in the open and closed state of fuel injector 1. ~~Equivalent~~ **The same or similar** components have been provided with matching reference signs.

As already mentioned earlier, conventional fuel injectors [[1]] have a convex transition region 13 in the area of the sealing seat, where an angle α enclosed by surfaces 14 and 15 is greater than, or at most precisely 180°. This causes a raised or at best smooth transition region 13 where -- as can be gathered clearly from Figure 3 on the right -- edges 16 and 17 ~~obviously~~ jut out since the sum of two edge angles γ are significantly smaller than 90° due to large angle α. However, sharp edges 16 and 17 are susceptible to damage such as notches, which may occur when fuel injector 1 is transported or installed.

Therefore, as ~~shown~~ **illustrated** in Figures 2 and 3 on the left, ~~it suggests itself to choose~~ a concave ~~design~~ **arrangement is provided** for transition region 13 of fuel injector 1 in the area of the sealing seat, so that angle α ~~lying~~ between surfaces 14 and 15 is smaller than 180°. As a result, the sum of both edge angles γ of edges 16, 17 on nozzle body 3 and valve-closure body 5 is greater than 180°, i.e., individual edge angles γ are greater than 90°, and the two edges 16, 17 are obtuse-angled. As a result, edges 16 and 17 ~~are~~ **may be** more robust with respect to damage. In addition, edges 16 and 17 are also protected by the concave form of transition region 13, since they are recessed relative to a surface plane 18, indicated by dashed lines, of fuel injector 1.

~~The present invention is not limited to the exemplary embodiment shown, but is~~ **It should be understood that example embodiments of the present invention may** also able to be utilized for electromagnetically actuable fuel injectors 1.

~~Abstract~~

ABSTRACT

A fuel injector ~~(1)~~ for the direct injection of fuel into the combustion chamber of an internal combustion engine includes a valve needle ~~(4)~~, which is ~~situated~~ **arranged** in a nozzle body ~~(3)~~, is actuable by an actuator ~~(7)~~ and acted upon by a restoring spring ~~(9) in~~ such ~~a manner~~ that a valve closure member ~~(5)~~, which is in operative connection to the valve needle ~~(4)~~ and faces the combustion chamber, is kept in sealing contact on a valve seat surface ~~(6)~~ in the non-actuated state of the actuator ~~(7)~~. A surface of the fuel injector ~~(1)~~ has a concave design in a transition region ~~(13)~~ between the nozzle body ~~(3)~~ and the valve-closure member ~~(5)~~.

~~(Fig. 3)~~